NX

NX Thermal

FE-based finite volume thermal solver technology to efficiently simulate heat transfer phenomenon

fact sheet

Siemens PLM Software

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Summary

NX® Thermal is an engineering analysis solution (fully integrated into the NX Advanced Simulation environment) that simulates thermal and heat transfer for complex products and processes within large NX assemblies. It allows for thermal and heat transfer simulations and offers high fidelity simulation of radiative, conductive and convective heat transfer. NX Thermal addresses thermal analysis requirements in industries including automotive and transportation, consumer products and appliances, energy, medical, high-tech electronics and defense. NX Thermal can also be used with NX Flow, an NX-integrated CFD solution, for coupled thermo-fluid simulation.

Features

Thermal couplings for joining disjoint solid or surface meshes within an NX assembly

NX thermo-fluid and thermo-elastic interactions

NX integrated thermal and heat transfer toolset

Benefits

Allows for investigation of multiple 'what-if' scenarios involving complex assemblies

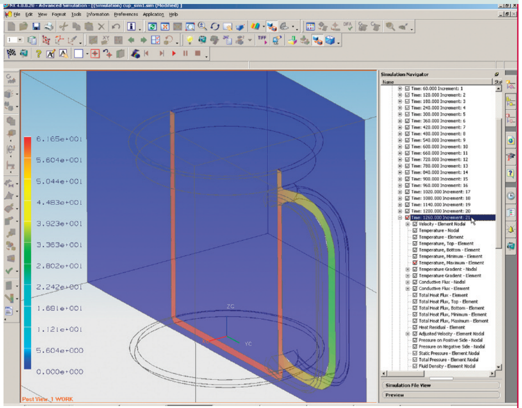
Allows for building of assemblies by modeling heat flow between unconnected parts and components

Enables the user to simulate strong and fully-coupled thermo-fluid interactions, including proper treatment of radiative heat transfer

Supports mapping results to a Nastran FE model for thermo-elastic analysis

Works within an NX integrated environment, allowing users to incorporate all capabilities of NX advanced simulation

NX Thermal uses high order finite volume-based technology on a FE mesh to accurately and efficiently simulate heat transfer phenomenon. It combines the versatility of FE-based analysis with the accuracy of a finite-difference scheme. The NX Thermal solver technology allows simulation of NX parts and assemblies within complex thermal environments. The solver and modeling features include:



Solver capabilities

- Steady-state (linear and nonlinear)
- Transient (linear and nonlinear)
- Material nonlinear thermal properties
- Axi-symmetric modeling
- Cyclic thermal problems
- Iterative conjugate gradient solver technology
- Fully coupled conduction, radiation and convection heat transfer simulation

Thermal couplings technology for modeling thermal contacts within NX assemblies

- Thermally connect disjoint and dissimilar mesh faces and edges
- Surface-to-surface, edge-to-edge or edge-to-surface contact modeling between parts: constant, time or temperature-dependent coefficient of heat transfer, resistance or conductance
- Radiative exchange between disjoint part faces and faces within a single part
- Interface modeling between connected parts: constant, time or temperature-dependent coefficient of heat transfer, resistance or conductance
- Convective exchange correlations between faces: parallel plates, concentric spheres or cylinders

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Applied heat loads

- Constant and time-dependent heat loads
- Constant and time-dependent heat flux
- Constant and time-dependent heat generation
- Ability to control all applied loads with temperature-controlled thermostat conditions or PID controllers

Temperature boundary conditions

- Constant temperature for steady-state or transient
- Time varying for transient and for nonlinear steady-state
- Thermostat temperature controls

Conduction heat transfer

- Ability to handle large conduction heat transfer models (memory efficient data scheme)
- Temperature-dependent conductivity
- Temperature-dependent specific heat
- Orthotropic conductivity
- Heat of formation at phase change temperature

Convection heat transfer

- Constant, time and temperature-dependent heat transfer coefficients
- Parameter and nonlinear temperature gradient functions
  - Free convection
    - Correlation based free convection to ambient for inclined plates, cylinders and spheres
  - Forced convection
    - Correlation based convection for plates, spheres and cylinders in forced fluid flow

Radiation heat transfer

- Constant and temperature-dependent emissivity
- Multiple radiation enclosures
- Diffuse view factor calculations with shadowing
- Net view factor calculations
- Adaptive scheme for view factor sum optimization
- Hemicube-based view (form) factors calculation using graphics card hardware
- Radiation patch generation to condense large element-based radiation models
- Radiation matrix controls and parameters

Initial conditions

- Starting temperatures for both steady-state and transient
- Starting temperatures from previous solution results, from file

Solver and solution attributes

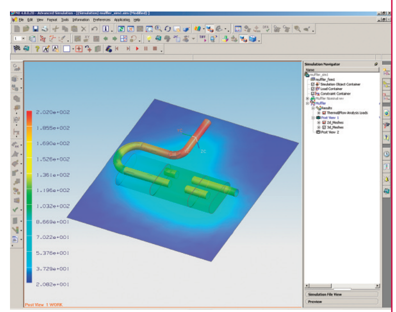
- Restart conditions, cyclic convergence criteria
- Direct access to solver parameters
- Solver convergence criteria and relaxation factors
- Solver monitor with solution convergence and attributes
- Intermediate results display and recovery directly from solver progress monitor

Other features

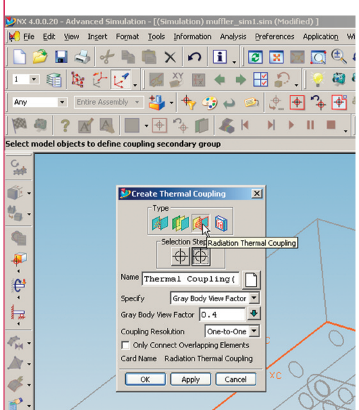
- Results Reporter
  - Summary of results to Excel worksheets
  - Heat flow calculation between groups
  - Heat maps
- Complete or partial deactivation of selected elements (for radiation form factors calculations)
- Temperature mapping for Nastran FE models with dissimilar mesh

Simulation results

- Temperatures
- Temperature gradients
- Total loads and fluxes
- Conductive fluxes
- Convective fluxes
- Convection coefficients
- Residuals
- Heat maps
- View factors sums



Features

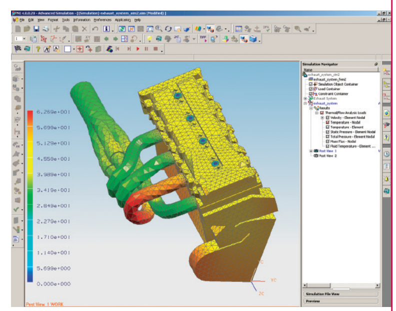


Thermal couplings for joining disjoint solid or surface meshes within NX assembly context. Thermal couplings provide a powerful and efficient capability for building assemblies by modeling heat flow between unconnected parts and components. Multiple what-if scenarios and positioning of parts within an assembly can be investigated by defining the thermal coupling parameters between unconnected parts only once. Heat transfer paths are automatically created between elements on opposing parts at runtime. These conductances are established based on surface proximity, and they account for overlap and mismatch between disjoint and dissimilar meshes exchanging heat, allowing parts to be moved freely within the assembly prior to running the analysis. Thermal coupling types include conductive, radiative, convective and interface couplings. Thermal couplings can also be defined as varying with different model parameters such as temperatures or heat loads.

NX thermo-fluid and thermo-elastic interactions. The heat transfer modeling capabilities can be explicitly combined with the NX Flow computational fluid dynamics (CFD) solution (also available within the NX Advanced Simulation environment). This combination allows a user to simulate strong and fully-coupled thermo-fluid interactions problems, including integration of radiative heat transfer. When NX Flow and NX Thermal are purchased together, the thermo-fluid solver is automatically turned on within NX at no additional cost, offering both conduction and radiation modeling to be fully coupled with 3D fluid flow. Furthermore, NX Thermal temperature results can be mapped to a separate Nastran FE model for thermo-elastic analysis.

Native to NX, integrated thermal and heat transfer solution. NX Thermal is integrated within the native NX portfolio and takes full advantage of the NX Advanced Simulation environment. The NX integrated application allows both skilled engineers and thermal specialists to avoid any additional transfer of input files or geometry conversions and manipulations breaking the associative link between the NX geometry and FE tasks. The thermal model is synchronized with the NX design and assembly intent through NX data associativity. Complete associativity with the design geometry means that the thermal mesh is automatically updated when the design or assembly is modified.

NX provides NX Thermal users with a broad set of tools for creating thermal models and analysis-ready geometry. A user can automatically (or manually) create an idealized part where easy abstraction of unnecessary geometrical features can be achieved. Every geometrical abstraction is associative to the NX part and assembly context. Automated free meshing tools enable quick parts modeling using precise sketches, surfaces and solid geometry. The user can refine the mesh in critical areas and selectively control mesh density, minimizing or optimizing model size for rapid and accurate solution.



By virtue of being integrated within the NX environment, NX Thermal provides the ability to model, catalog and share parts and material libraries among the NX design team, thereby minimizing tedious rework and potentially costly modeling errors.

Product availability

NX Thermal is an add-on module in the new suite of Advanced Simulation applications available within the NX architecture. It requires a core seat of either NX Advanced FEM or NX Advanced Simulation as a prerequisite. When used in combination with NX Flow, NX Thermal provides a coupled multi-physics solution for complex fluid flow/thermal applications.

NX Thermal is available on most major hardware platforms and operating systems including Unix, Windows and Linux.

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